DOCUMENT RESUME

ED 046 544 24 PS 004 433

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TITLE The Relationship of Individual Differences in the Orienting Response to Complex Learning in Kindergartners. Report from the Motivation and Individual Differences in Learning and Retention Project.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.
REPORT NO UW-WRDCCL-TR-132
BUREAU NO BR-5-0216
PUB DATE Jul 70
CONTRACT OEC-5-10-154
NOTE 13p.; ED 031 229 is an earlier version of this paper that was presented at the annual meeting of the AERA, Los Angeles, California, February 6-9, 1969

EDRS PRICE EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS Aural Stimuli, Discrimination Learning, *Individual Differences, Kindergarten Children, *Learning Processes, Measurement Techniques, *Paired Associate Learning, *Physiology, Pictorial Stimuli, Response Mode, *Sex Differences
IDENTIFIERS *Orienting Response

ABSTRACT

Heart rate change was used as the index of the orienting response (OR) of 102 kindergarten children. Heart rate change was measured by recording heart rate upon the presentation of tones. 15 similar tones followed by a different, 16th tone, were used. From this data the children were divided into high, medium, or low orientors. Following the "OR" testing session, 96 subjects received two pictorial analogues of verbal discrimination tasks. Subsequently, 65 subjects received a paired-associate (P-A) task. Learning on these tasks, when related to "OR" classification, showed that low "OR" males and medium "OR" females performed best, while medium "OR" males and low "OR" females performed worst. This finding was significant for the P-A task, indicating a relationship between "OR" classification and learning performance on this particular P-A task. It is difficult to explain the fact that performance was reversed between the sexes. (WD)

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PA-24
BR-5-0216

ED046544

Technical Report No. 132

THE RELATIONSHIP OF INDIVIDUAL DIFFERENCES IN THE ORIENTING RESPONSE TO COMPLEX LEARNING IN KINDERGARTNERS

By Frank H. Farley and Mary E. Manske

Report from the Motivation and Individual Differences in Learning and Retention Project

Frank H. Farley, Principal Investigator

A paper presented at the annual meeting of the American Educational Research Association February 6-9, 1969, Los Angeles, California

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

July 1970

PS004433

Published by the Wisconsin Research and Development Center for Cognitive Learning, supported in part as a research and development center by funds from the United States Office of Education, Department of Health, Education, and Welfare. The opinions expressed herein do not necessarily reflect the position or policy of the Office of Education and no official endorsement by the Office of Education should be inferred.

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This Technical Report is from the Motivation and Individual Differences in Learning and Retention Project from Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities. Contributing to these Program objectives, the Learning and Memory Project has the long-term goal of developing a theory of individual differences and motivation. The intermediate objective is to generate new knowledge of the learning and memory processes, particularly their developmental relationship to individual differences and to motivation.

ACKNOWLEDGEMENT

The authors would like to express their great appreciation to Mr. J. W. Dalton, Principal of Glendale School, Monona, Wisconsin, and his kindergarten teachers (Mrs. Richard Krumbiegel, Mrs. Wanda Magee, and Mrs. Marjorie Putnam) for their outstanding cooperation and assistance in completing this research.

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ABSTRACT

The present study investigated an assumption that individual differences in magnitude of the orienting response (OR) to a nonsignal tone, measured by heart-rate (HR) deceleration, is predictive of performance in a highly unrelated learning situation. It utilized several learning tasks that are implied to involve different learning processes; namely, concept identification, discrimination learning, and one-trial paired-associate (PA) learning. In addition, it employed Kindergarten-aged subjects of both sexes classified into High, Medium, or Low OR categories.

Ninety-six subjects were assessed on HR change to a 1000 cps. tone with the distribution ORs being divided into thirds to form High, Medium, and Low OR groups. At a later time, 96 subjects were administered the concept identification and discrimination learning tasks and 65 subjects were tested in the one-trial PA task.

A significant quadratic trend was obtained between OR classification and PA learning, with the direction of the trend highly dependent on sex. Females displayed the relationship in an inverted-U form, i.e., better performance was associated with the Medium OR condition, whereas males displayed the relationship in a U form, i.e., better performance was associated with the High and Low OR conditions. Although the shape of the trends was similar for the two other tasks, they were not significant at accepted levels.

It was concluded that OR classification by the present method among young children can be predictive of subsequent PA learning, and that this method holds promise where learning is concerned as an exceedingly early non-verbal predictor that should be free of race and social class influences.

I
INTRODUCTION

The Orienting Response (OR) is usually considered to involve a constellation of physiological processes that is brought about by a change of stimulation in the environment. Some of the indices that have been used to measure this phenomenon are digital vasoconstriction coincident with cephalic vasodilation (Sokolov, 1963), GSR magnitude (Raskin, 1963), and heart rate deceleration (Chase, Graham, & Graham, 1968).

A few experimenters have investigated the contributions of individual differences in the orienting response to conditioning and complex processes. The empirical work has been conducted entirely with adults who have been classified as either "High" or "Low Orientors" on the basis of their physiological responses to discrete stimulation.

The OR has been studied from a number of approaches. One approach stems from the work of Sokolov (1963) that investigated the hypothesis that the occurrence of an OR enhances stimulus reception, both within and across sensory modalities. Another area of research has studied the relationship of the OR to established areas of behavioristic interest, such as conditioning, learning, and reinforcement. It is currently hypothesized that the occurrence of an OR is necessary for conditioning to occur. It has also been implied that the OR is closely related to the concepts of arousal and reinforcement. In addition to the assumption that the OR is related to learning, Maltzman and Raskin (1965) have also assumed that there is a wide range of individual differences in the magnitude of the OR that is reliably evoked in different subjects who are experiencing the same stimulus conditions. These authors also hypothesized that the OR is related to the discrimination of such complex stimuli as words, in addition to raising the sensitivity of sensory analyzers.

Raskin (1963) studied the relationship of individual differences in the OR and performance in a semantic conditioning and generalization experiment. Galvanic skin response (GSR) changes comprised the conditioned response. The OR was operationally defined as the magnitude of the GSR evoked by the first unconditioned stimulus (UCS), a burst of white noise. High and Low Orienting subjects were identified on the basis of their GSR magnitudes. It was established that High OR subjects showed reliably greater conditioning, and semantic generalization that Low OR subjects.

As Maltzman and Raskin pointed out, it is necessary to have different measures of the OR and learning in order to establish any kind of generality concerning the relationship of the OR to learning.

Other investigators have reported the relationship of individual differences in the OR and performance on a paired-associates (P-A) learning task. Belloni (1964) classified subjects into High and Low OR categories on the basis of the magnitude of their GSR to a word. The performance measures used were two paired-associate lists, classified as "easy" and "difficult." It was hypothesized that the OR could be viewed as an index of a "discriminative ability" and that High OR subjects would learn both lists more quickly. The author argued that those conceiving of the OR as a measure of drive would predict that High OR subjects would do better on the easy list and that Low OR subjects would do better on the difficult list. When the results were investigated within each sex, it was found that High OR males learned the difficult task reliably faster than the Low OR males. It was concluded that the OR was related to discriminative ability and that it could not be viewed as a drive index, since Taylor Manifest Anxiety Scores were not able to predict performance on the paired-associates list.

Nies (1964) used the same P-A lists in a similar experiment and categorized subjects

into High and Low OR groups on the basis of magnitude of the GSR to a 90 db. noise. Only male subjects were used. The High OR group was superior to the Low OR group on both lists when response speed was used as a measure of performance. The High OR group also required fewer trials to criterion than the Low OR group on the difficult list.

There is some evidence, then, that individual differences in the OR can be used to predict performance in a highly unrelated situation. It was the purpose of the present study to extend these conclusions in several directions.

The first question was, would there be OR/learning relationships in young children, and, secondly, would interactions of OR and sex in relation to learning be manifest at this early age? Third, it was hoped that classification into the three categories of High, Medium, and Low OR would be more informative than the previously used High and Low. Several investigators (Hebb, 1949; Berlyne, 1960) have suggested that arousal and performance are related by a U-shaped function. Considering the OR as an indicant of arousal, at least three such groups are required to study this relationship. Fourth, in order to avoid many problems in GSR measurement and interpretation and to bring greater generality to previous findings, a relatively new index of the OR was used; namely, heart rate change. Graham & Clifton (1966) and Chase & Graham (1967) have provided support of the hypothesis that heart rate deceleration is a major component of the OR. Fifth, it was considered desirable to establish the relationship of the OR and performance across several different learning tasks that presumably involve different processes; namely, simple concept learning, discrimination learning, and paired-associates learning.

II
METHOD

SUBJECTS

The Ss were Kindergarten children, ages 5 and 6.

PROCEDURE

Both ECG and beat-to-beat cardiotachometer readings of the heart beat and heart rate were obtained by right-arm-to-left-leg electrode placement and use of a Gilson M5P polygraph. Experimenter (E) always remained in the same room with the subject but out of eyesight. Continuous white noise was delivered freefield and the intensity of the noise and polygraph combined was 58 db. Fifteen tones (trials) (1000 cps.) were delivered freefield at an intensity of 61 db. A sixteenth tone (2000 cps.) was delivered at the intensity of 70 db. Tones were presented every 10 seconds (stimulus offset to stimulus onset) and lasted for 5 seconds. Resting measures were recorded for 3 minutes prior to presentation of the tones.

The measure of the OR was obtained using the response to the first tone. It was also hoped that the sixteenth tone would produce an OR because of the change in stimulus frequency and intensity. The measure of the OR was the difference between pre-stimulus and post-stimulus heart rate. Pre-stimulus level was designated as the slowest heart rate during the 3 seconds preceding stimulus onset and post-stimulus level was designated as the slowest heart rate in the 3 seconds following stimulus onset.

A covariance analysis of the kind recommended by Benjamin (1963) was performed in order to see if it was necessary to adjust heart rate change scores to take into account the Law of Initial Values.

A distribution of scores was made up on the basis of subjects' heart rate change ranging from high deceleration through no change through acceleration. The distribution was then divided into thirds and subjects were classified as either High, Medium, or Low Orientors.

Immediately following the OR testing session, the subject was presented with the learning tasks. Ninety-six subjects received the first two tasks which were pictorial analogues of a verbal discrimination task. Six pairs of stimulus pictures were presented to the subject, one of which was designated as correct. The subject's task was to learn to point to all of the correct pictures to a criterion of one perfect trial. The first problem could also be considered a simple concept learning task since all the items that were designated as correct were instances of the concept class of "animals." The second task could not be solved by the use of a concept mediator, since E arbitrarily designated at random which of the stimuli were correct.

The two picture discrimination tasks were scored on the basis of errors and trials to the criterion of one perfect trial. The third problem was a modified P-A task in which 65 subjects were shown five pairs of pictures serving as the stimuli and responses. The subject has to learn which pictures "went together." Each pair was presented for 30 seconds. Immediately after the series of six pairs was presented once, the subject was given the stimulus items and was asked to match them with the response items. The response measure used was the number of correct matchings.

III
RESULTS

Mean heart rate deceleration of the 96 subjects who participated in the picture discrimination tasks was 3.51 and 2.06, respectively, for Trial 1 and Trial 16. Mean heart rate deceleration for the 65 subjects who received the paired-associates task was 3.95 and 2.15, respectively, for Trial 1 and Trial 16.

The correlation between pre-stimulus heart rate and heart rate change was computed to test for the operation of the Law of Initial Values on Trial 1 and Trial 16. Since none of these correlations was significant, subsequent analyses were based on unadjusted heart rate change scores.

ANALYSES BASED ON TRIAL I OR CLASSIFICATION

The mean number of errors on the paired-associates task is shown in Figure 1. A least-squares analysis of variance showed a significant main effect of sex ($p < .005$), males having fewer errors than females. There was also a significant interaction of OR classification and sex ($p < .005$) which is presented graphically in Figure 1. Subsequent trend tests indicated a significant quadratic trend by sex interaction ($p < .001$). For males, the Low OR group produced the least number of errors and the Medium OR group the greatest number of errors. On the other hand, for females the trend was reversed. Low OR females had the greatest number of errors whereas Medium OR females had the least number of errors.

Although the results of errors on picture discrimination Tasks I and II are in the same direction as results on the paired-associates task, as shown in Figure 2 there were no significant main effects or interactions shown by analysis of variance. Subsequent tests for trend showed a quadratic trend by sex interaction for errors on Task I at the .10 level and errors on Task II at the .09 level. Although this does not reach

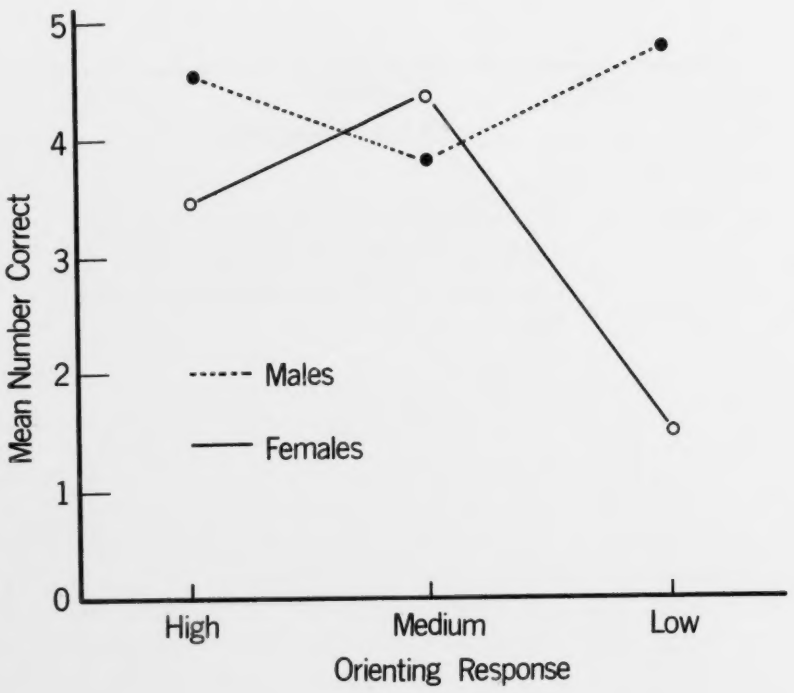

Figure 1. Mean Number Correct on the Paired-associates Task as a Function of OR Classification and Sex.

accepted levels of significance, one's confidence is increased due to similarity of these results and the previous results on the P-A task.

ANALYSES BASED ON TRIAL 16 OR CLASSIFICATION

A least-squares analysis of variance of the number of errors on the P-A task revealed no

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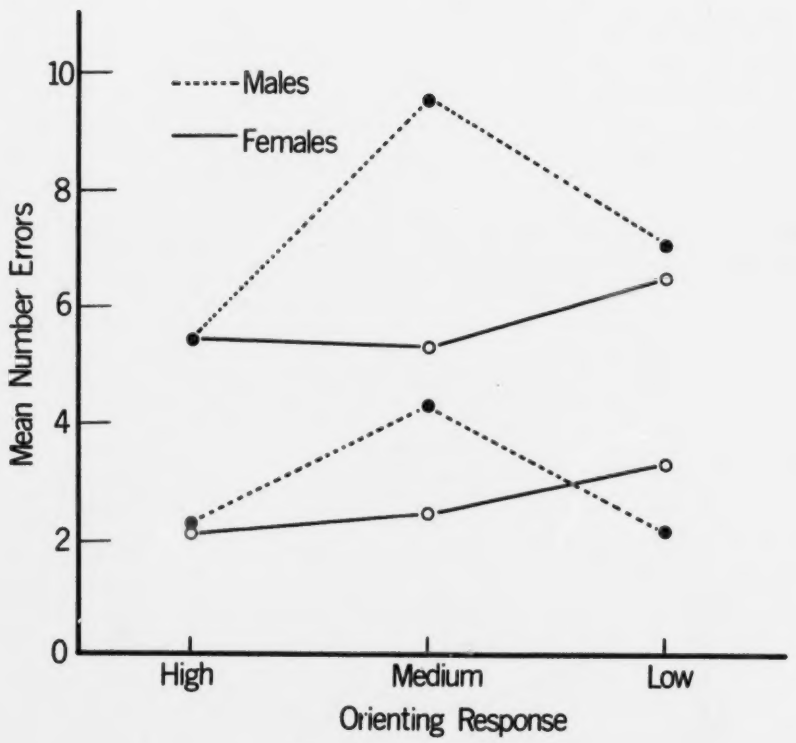

Figure 2. Mean Number of Errors on Picture-discrimination Tasks I and II as a Function of OR classification and Sex.

significant main effect of OR classification or a significant OR by sex interaction. A subsequent trend analysis indicated that the sex by quadratic trend interaction only reached significance at the .10 level. The shape of the trend for males is in the same direction as the results based on Trial 1 Classification.

The results for picture discrimination Tasks I and II demonstrated that neither errors to criterion or trials to criterion showed a significant main effect of OR classification or a significant interaction of OR and sex. A subsequent trend analysis indicated only a significant linear trend ($p < .02$) for trials to criterion on picture-discrimination Task II. Low Orientors required the greatest number of trials and High Orientors required the fewest number of trials.

IV
DISCUSSION

From these results, then, it appears that there is a relationship between individual differences in magnitude of the Orienting Response and learning performance on a modified paired-associates task. In addition, sex shows a strong interaction with this relationship. These results do not appear to be consistant with the earlier results of Nies and Belloni who found High Orienting males to be superior in performance to Low Orienting males. With the present three categories, High, Medium, and Low, as opposed to their High and Low, a trend was obtained for males in which optimal performance was associated with either a High or Low classification and poorer performance associated with the Medium Orienting category. For females, the trend was reversed as optimal performance was associated with the Medium Orienting category with the Low Orienting category being clearly associated with poorest performance. Although the results for females lend some support to the hypothesis that a moderate level of arousal is optimal for performance on the paired-associates task, this conclusion for females was not consistent across the other two tasks. Perhaps the differences in tasks can be conceptualized as differences in memory requirements demanded, the paired-associates task involving the use of short-term memory mechanisms while the picture discrimination tasks, using several trials to reach criterion, required the use of long-term memory mechanisms. On the other hand, for males, performance trends seem to be consistent across tasks. In general, overall male performance was better than that of females and was quite high. Perhaps some kind of ceiling effect was operating, i.e., the task was too easy for males due to cross-sex experimenter-subject relations (a female experimenter tested the subjects).

Why sex should be interacting so strongly with orienting classification is a difficult question and one to which no adequate answer is readily available. The importance of analyzing for sex differences is emphasized where future studies of this kind are concerned. All too often the possibility of analyzing for sex interactions is omitted from the design and important information is lost. In sum, it appears that Orienting Response Classification could be an important non-verbal predictor of children's performance in paired-associate learning if sex is taken into account. In addition, it is a predictor that presumably could be otained very early in the organism's life time, conceivably in the neo-natal period.

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